

What is claimed is:

1. A method of manufacturing a semiconductor device having a composite film composed of a silicon included organic film and an organic film, said method comprising the steps of:
  - 5 preparing gas plasma of mixed nitrogen and hydrogen; and
  - etching said organic film by the use of said gas plasma.
2. A method of manufacturing a semiconductor device as claimed in claim 1,
  - 10 said organic film being formed on said silicon included organic film, wherein an opening portion is formed in said organic film by the use of said gas plasma with said silicon included organic film functioning as an etching stopper.
3. A method of manufacturing a semiconductor device as claimed in claim 1,
  - 15 said silicon included organic film being formed on said organic film, wherein an opening portion is formed in said organic film by the use of said gas plasma with said silicon included organic film functioning as an mask.
4. A method of manufacturing a semiconductor device as claimed in claim 1,
  - 20 said silicon included organic film being first and second silicon included organic films, said organic film being formed on said first silicon included organic film, said second silicon included organic film being formed on said organic film, wherein an opening portion is formed in said organic film by the use of said gas plasma not only with said second silicon included organic film functioning as an
  - 25 mask but also with said first silicon included organic film functioning as an etching stopper.
5. A method of manufacturing a semiconductor device as claimed in claim 1, said method comprising the steps of:

forming said silicon included organic film and an inorganic insulating film on said organic film;

forming an opening portion penetrating said inorganic insulating film down to said silicon included organic film by using a photo resist organic film  
5 pattern;

selectively removing said photo resist organic film pattern by the use of gas plasma of mixed nitrogen and hydrogen; and

etching said silicon included organic film and said organic film with said opening portion formed in said inorganic insulating film functioning as an  
10 mask.

6. A method of manufacturing a semiconductor device as claimed in claim 1, an organic film existing on a surface of stacked films comprising said silicon included organic film and said inorganic insulating film, said organic film also  
15 existing within an opening portion formed in said stacked films, wherein said organic film is removed therefrom by the use of gas plasma of mixed nitrogen and hydrogen.

7. A method of manufacturing a semiconductor device as claimed in claim 1, wherein said silicon included organic film is composed of a polymer of divinyl-  
20 siloxane-benzocyclobutene.

8. A method of manufacturing a semiconductor device, said method comprising the steps of:

25 (a) forming a silicon included organic film composed of an organic compound including silicon;

(b) forming a silicon non-included organic film composed of an organic compound including no silicon to be connected with said silicon included organic film; and

(c) etching said silicon non-included organic film by the use of an etching gas including nitrogen and hydrogen.

9. A method of manufacturing a semiconductor device, said method  
5 comprising the steps of:

(d) forming a silicon included organic film composed of a first organic compound including silicon on an upper side of a substrate;

(e) forming a silicon non-included organic film composed of a second organic compound including substantially no silicon on an upper side of said  
10 silicon included organic film; and

(f) etching said silicon non-included organic film by the use of an etching gas including nitrogen and hydrogen to expose said silicon included organic film.

15 10. A method of manufacturing a semiconductor device as claimed in claim 9, said method further comprising the steps of:

(g) forming another silicon included organic film composed of an organic compound including silicon on an upper side of said silicon non-included organic film;

20 (h) forming an opening portion in said another silicon included organic film; and

said (f) step including:

(i) etching said silicon non-included organic film from said opening portion of said another silicon included organic film by the use of an etching gas  
25 including nitrogen and hydrogen to expose a part of a surface of said silicon included organic film.

11. A method of manufacturing a semiconductor device as claimed in claim 10, said method further comprising the step of:

(j) etching said silicon included organic film and said another silicon

included organic film at the same time from an upper side of said another silicon included organic film to form another opening portion penetrating said silicon included organic film from said a part of a surface of said silicon included organic film down to said substrate; and

5        said another silicon included organic film being larger than said silicon included organic film in thickness.

12. A method of manufacturing a semiconductor device, said method comprising the steps of:

10        (k) forming a silicon non-included organic film composed of a first organic compound including substantially no silicon on an upper side of a substrate;

          (l) forming a silicon included organic film composed of a second organic compound including silicon on an upper side of said silicon non-included organic film;

15        (m) forming an opening portion in said silicon included organic film; and

          (n) etching said silicon non-included organic film from said opening portion of said silicon included organic film by the use of an etching gas including nitrogen and hydrogen to expose a substrate.

20        13. A method of manufacturing a semiconductor device, said method comprising the steps of:

          (o) forming a silicon included organic film composed of a first organic compound including silicon;

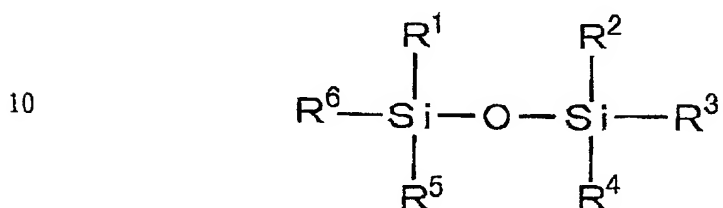
          (p) forming an opening portion in said silicon included organic film;

25        (q) forming a silicon non-included organic film composed of a second organic compound including substantially no silicon within said opening portion; and

          (r) removing said silicon non-included organic film by the use of an etching gas including nitrogen and hydrogen.

14. A method of manufacturing a semiconductor device as claimed in claim 8, wherein said etching gas including substantially no oxygen.

5 15. A method of manufacturing a semiconductor device as claimed in claim 9, wherein said first organic compound includes a polymer of a compound having the following structural formula;



wherein R1 through R6: hydrocarbon radical

15 16. A method of manufacturing a semiconductor device as claimed in claim 9, wherein said first organic compound includes a polymer of divinyl-siloxane-benzocyclobutene.

17. A method of manufacturing a semiconductor device as claimed in claim 9,  
20 wherein said first organic compound includes a polymer of siloxane-polyimide.

18. A method of manufacturing a semiconductor device as claimed in claim 9, wherein said first organic compound is smaller than a silicon oxide film in relative dielectric constant.

25 19. A method of manufacturing a semiconductor device as claimed in claim 9, wherein said second organic compound is smaller than a silicon oxide film in relative dielectric constant.

20. A semiconductor device comprising:

a semiconductor substrate;

an organic film having low dielectric constant and including no silicon,  
said organic film being formed on said semiconductor substrate; and

5 a silicon included organic film formed on a lower surface, an upper surface,  
or both lower and upper surfaces of said organic film having low dielectric  
constant.

21. A semiconductor device as claimed in claim 20, wherein a conductive film  
10 is selectively buried into an opening portion of stacked films consisting of said  
silicon included organic film formed on a lower surface, an upper surface, or  
both lower and upper surfaces of said organic film having low dielectric  
constant.

22. A semiconductor device as claimed in claim 20, wherein said silicon  
15 included organic film is formed by a polymer of divinyl-siloxane-  
benzocyclobutene.

23. A semiconductor device comprising:

a silicon included organic film composed of a first organic compound  
20 including silicon; and

a silicon non-included organic film which is composed of a second organic  
compound including substantially no silicon and which is connected with said  
silicon included organic film.

25 24. A semiconductor device comprising:

a substrate;

a silicon included organic film which is formed on an upper side of said  
substrate and which is composed of a first organic compound including silicon;

a silicon non-included organic film which is formed on an upper side of

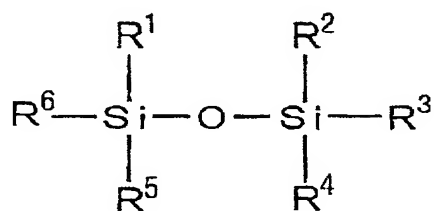
said silicon included organic film and which is composed of a second organic compound including substantially no silicon and in which a wiring trench is formed down to said silicon included organic film; and

a conductor formed within said wiring trench.

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25. A semiconductor device as claimed in claim 23, wherein said first organic compound includes a polymer of a compound having the following structural formula;

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wherein R1 through R6: hydrocarbon radical

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26. A semiconductor device as claimed in claim 23, wherein said first organic compound includes a polymer of divinyl-siloxane-benzocyclobutene.

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27. A semiconductor device as claimed in claim 23, wherein said first organic compound includes a polymer of siloxane-polyimide.

28. A hard mask, characterized in that said hard mask is for use in etching an organic film composed of an organic compound including no silicon, said organic film including a silicon included organic film composed of an organic compound including silicon.

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29. An etching stopper film, characterized in that said etching stopper film is for use in etching an organic film composed of an organic compound including no silicon, said organic film including a silicon included organic film composed of an organic compound including silicon.